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Integrated Human-in-the-Loop Ground Testing –
Value, History, and the Future

Donald L. Henninger, Ph.D.
Division Chief Technologist
Crew & Thermal Systems Division
NASA Johnson Space Center
2101 NASA Parkway, Houston, Texas, 77058

Systems for very long-duration human missions to Mars will be designed to operate reliably for many years and many of these systems will never be returned to Earth. The need for high reliability is driven by the requirement for safe functioning of remote, long-duration crewed systems and also by unsympathetic abort scenarios. Abort from a Mars mission could be as long as 450 days to return to Earth. The key to developing a human-in-the-loop architecture is a development process that allows for a logical sequence of validating successful development in a stepwise manner, with assessment of key performance parameters (KPPs) at each step; especially important are KPPs for technologies evaluated in a full systems context with human crews on Earth and on space platforms such as the ISS. This presentation will explore the implications of such an approach to technology development and validation including the roles of ground and space-based testing necessary to develop a highly reliable system for long duration human exploration missions. Historical development and systems testing from Mercury to the International Space Station (ISS) to ground testing will be reviewed. Current work as well as recommendations for future work will be described.